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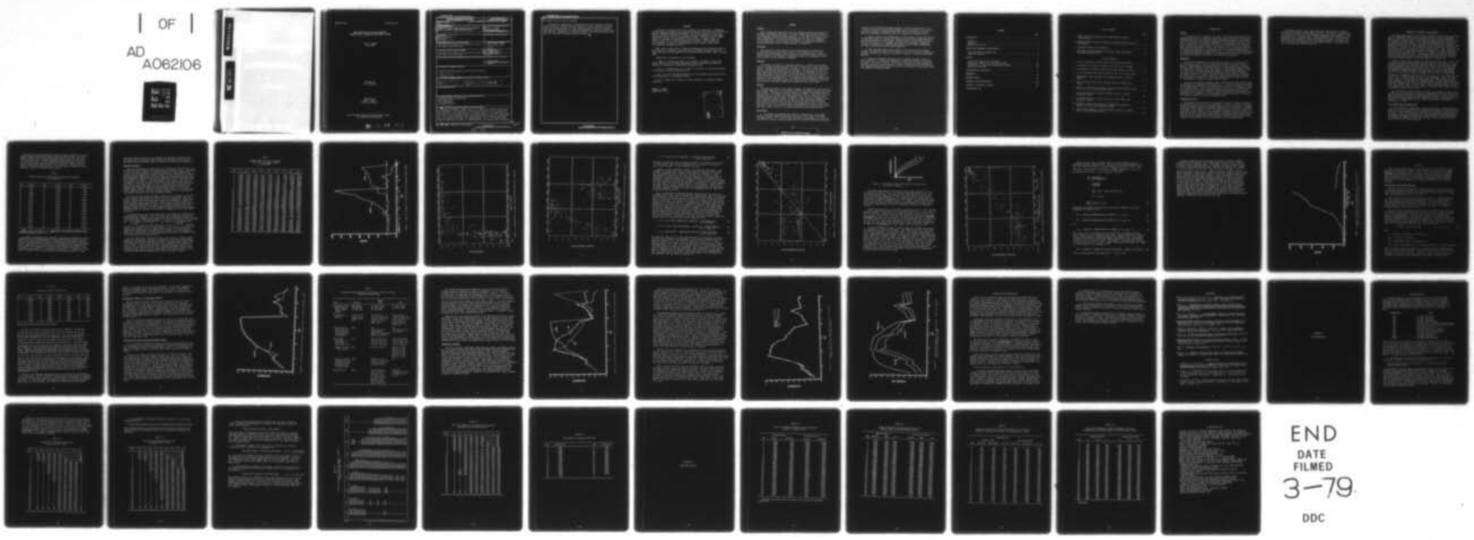

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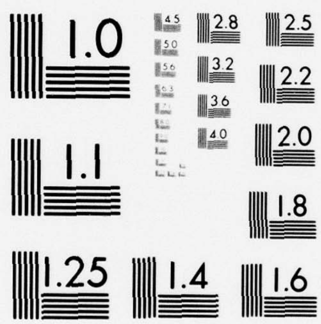

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FORECASTING NAVAL ENLISTED RETENTION BEHAVIOR UNDER ALTERNATIVE RETIREMENT SYSTEMS

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Recently, substantial changes in the U.S. military retirement system have been proposed by various groups. While the primary goal is the reduction of total personnel costs (particularly retirement costs), a more significant consideration is the resulting change in retention behavior of active duty personnel. For the Navy enlisted force, which already faces retention problems in some high technology ratings, the implementation of a new retirement system without considering its effect on force behavior could easily lead to personnel

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shortages and force quality problems.

A technique is presented for forecasting Total Navy enlisted retention rates and service continuation rates under the economic incentives of alternative retirement systems. The same technique can be applied to enlisted rating groups characterized by relatively homogeneous occupations and retention behavior. Examples of forecasted retention rates and continuation rates under two different retirement systems are given.

FOREWORD

The effort described in this report supports the development of management decision models, an exploratory development objective under Task Area ZF55.521.010: Manpower Management Decision Technology. The overall objective of this task area is to develop techniques to improve the Navy's managerial decision-making capabilities in the area of manpower and personnel. The main effort in FY78 focused on problems in forecasting the Navy's military manpower budget in order to avoid cost overruns and personnel turbulence. This problem has been addressed, in part, by investigating the force behavior implications of alternative retirement policies.

This report is the third in a series documenting work in retirement analysis. The previous two (Chipman & Silverman, Note 1; Chipman, Silverman, & Willis, 1978) described the development of the Retirement Analysis Model (RAM), a costing model.

Appreciation is expressed to the following:

- CAPT R. J. Wallace and CAPT L. W. Fernald of the Bureau of Naval Personnel (Pers-24) for providing information on Navy retirement practices and sources of information on alternative retirement plans.

- Dr. R. J. Niehaus and Mr. B. C. Hall of the Office of Civilian Personnel for providing civilian occupational data.

- Dr. G. Gotz of the Rand Corporation for his assistance and, particularly, his formulation of the continuance model.

- Dr. J. Warner of the Center for Naval Analyses for providing technical assistance.

DONALD F. PARKER
Commanding Officer

SUMMARY

Problem

Navy planning and policy decisions often address problems where there are multiple, conflicting objectives. One such problem involves the evaluation of alternative military retirement policies. A retirement policy not only affects retirement and active duty personnel costs but also the composition of the enlisted force. To aid in the development of an effective retirement policy, models have been developed to forecast the continuation behavior of enlisted personnel, given an underlying set of assumptions.

Objective

The objective of this effort was to develop quantitative methods for evaluating alternative retirement systems. These methods could be used to evaluate various retirement policies for Navy enlisted personnel, such as those proposed by the President's Commission on Military Compensation (PCMC) and the Office of the Secretary of Defense.

Approach

To evaluate the effects on retention behavior of a particular retirement policy, a dynamic programming model was used to compute the present discounted value of remaining in the military as opposed to the value of retiring or leaving for civilian employment prior to retirement. By analyzing the relationship between the cost of leaving military service and retention rates, by pay grade and length of service (LOS), forecasting models involving the use of a logit function were developed to yield retention rates, given the economic incentives of any retirement policy. By combining the forecasted retention rates with the current continuation rates for those personnel continuing in service, predictions of Total Navy (ALNAV) LOS continuation rates can be made.

Results

The models described in this report represent the third step in the development of more advanced tools to assess the effects of proposed alternative retirement systems. The first step was documented in Chipman and Silverman (Note 1); and the second, in Chipman, Silverman, and Willis (1978). The analytic methods developed in the third step were operationalized in an interactive computer model--Retirement Analysis Model II (RAM II). This model was designed to forecast voluntary retention rates by pay grade and LOS, using three different logit functions (one for LOS 1-8, one for LOS 9-19, and one for LOS 20-31). Both LOS and the cost of leaving (COS) were significant variables in all three equations. RAM II was used to forecast continuation rates for the PCMC retirement plan as well as one of the latest proposals being considered by OSD.

Conclusions

1. The dynamic programming model appears to explain much of the ALNAV enlisted retention behavior experienced in FY76 and FY77 under the current retirement system. As a result of the statistical relationship, it is fair to conclude that a model can be developed that will forecast retention rates under

a variety of alternative retirement systems. The data requirements for such a model are large and require much organization and processing. Both the output from the dynamic programming model (the costs of leaving) and the LOS should be considered as possible predictor variables of retention rates.

2. Models similar to the ALNAV model can be developed for specific enlisted occupational groups to forecast reenlistment rates and LOS continuation rates for different skills or specialties. In this manner, the Navy will be able to predict the effects of a retirement system on its occupational communities. The data requirements are substantially greater than the ALNAV requirements, in terms of both processing and data acquisition.

3. While previous models were designed to cost alternative retirement systems, the model described in this report can be used to evaluate alternative economic incentives at any point in service in terms of resulting continuance behavior.

4. Based on preliminary analyses of two retirement proposals (PCMC and DoD) using RAM II, a substantial difference in enlisted retention is forecast relative to the current system. Particularly noticeable is the discrepancy in voluntary retention at those points of service lying between LOS 8 and LOS 20. This suggests that special attention be given to personnel in "mid-career" under the proposed retirement systems.

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INTRODUCTION

Problem

In recent years, as retirement costs have risen disproportionately to total defense manpower costs, alternative retirement policies have been considered. A problem associated with these alternative retirement schemes is the assessment of their costs and behavioral implications for active duty forces. Trade-offs in the area of force quality and quantity (as expressed by the personnel force configuration) versus implicit and explicit force costs must be examined when comparing retirement policies. Some factors to be considered include (1) the economic incentives of a retirement policy, (2) promotion probabilities, (3) involuntary separation probabilities, and (4) civilian earnings opportunities. Any methodology designed to address the problem of retirement policy evaluation must also pay particular attention to the underlying assumptions.

Background

The military retirement system has been the subject of increasing review and criticism by several sources, including Congress, active and retired military organizations, and the general public. Many alternative retirement plans have been proposed, including those by the Interagency Committee (1972), the Department of Defense (1972), the authors of the Retirement Modernization Act (1974-1977), the Defense Manpower Commission (1976), and Congressman Les Aspin (D-Wisconsin) (1976) (see Military Retirement Summary of Proposals and Studies, 1977). Currently, interest is being focused on plans proposed by the President's Commission on Military Compensation (1978) and the Office of the Assistant Secretary of Defense (White, Note 2).

To aid in the retirement analysis area, the Retirement Analysis Model (RAM) was developed by Chipman and Silverman (Note 1). This costing model is capable of providing costs related to active duty and retirement for virtually any type of retirement system. One of the RAM inputs is a set of 30 continuation rates that describes the retention behavior of enlisted personnel under the given retirement system and that, obviously, heavily influences the forecasted costs. Consequently, the emphasis in the retirement analysis has shifted to forecasting voluntary retention and LOS continuation rates.

Objective and Scope

The objective of this report is to specify in detail the approach taken to estimating force behavior and to provide some illustrative results. The methodology incorporates a dynamic programming model described in Chipman, Silverman, and Willis (1978), which was originally developed by Dr. Glenn Gotz of the RAND Corporation (Gotz & McCall, 1977). The report considers the data processing required for the Gotz model, a description and analysis of results from the Gotz model as applied to Navy enlisted personnel, the relationship between the output from the Gotz model and the Navy enlisted voluntary retention rates, and a summary of the retention and LOS continuation rate forecasting model.

Succeeding sections of the report offer some illustrative forecasts of alternative retirement systems using the model. The forecasts contained herein are clearly a result of the assumptions underlying the development of the Gotz model and its requisite data. Other assumptions and/or methods of data organization will naturally lead to different conclusions. The illustrated results are not intended to reflect the official position of the Navy, but they do indicate the capability for analyzing a variety of retirement plans as to both cost and force implications.

FORECASTING PERSONNEL FORCE BEHAVIOR

The methodology detailed in this report utilizes monetary values associated with (1) remaining in the military and (2) opting for civilian employment. These monetary values, which are expressed in present discounted dollars, are the outputs of the Gotz model. For a given pay grade and LOS, they express the expected lifetime earnings for an enlisted individual if he decides to remain in the Navy for at least 1 more year, or if he decides to leave the Navy and obtain a civilian job. The difference between the values of staying in and leaving the Navy is termed the cost of leaving (COL). Thus, a positive COL would imply that a risk-neutral person should remain in the Navy because his earnings would be greater than if he left. Similarly, a negative COL implies that he should leave the Navy. A risk-neutral person is one who, given two different expected lifetime earnings streams, will choose the one providing the largest income, whether it be from military or civilian life.

There are several basic assumptions underlying the Gotz model. First, the structure of the model implies that, for any given pay grade and LOS, a Navy enlisted individual is a long-term maximizer; that is, he considers possible lifetime earnings streams (both military and civilian) defined by promotion and involuntary separation probabilities as well as civilian opportunities. The expected lifetime earnings in the Gotz model are equal to the weighted sum of all future years' expected earnings with each year's earnings being discounted (or weighted) at the rate of $\beta^n = (1/(1 + \rho))^n$ for n years into the future, with ρ being the marginal rate of time preference. Thus, the nearer that a year is to the present, the more weight that would be given to that year's earnings. As the value of ρ becomes larger, β becomes smaller, and an individual becomes more of a short-term maximizer with very little regard being given for "distant" years into the future. Unless otherwise noted, ρ is set to a commonly used value of .1(β = .9091) (cf. Shishko, 1976; Gilman, in press; & Substantive discount rates, 1972).

The structure of the Gotz model also implies that persons are risk neutral and that they possess perfect information regarding military and civilian earnings and military promotion and separation probabilities. This may not be a particularly heroic assumption since personnel are generally aware of both promotional and civilian opportunities. These assumptions are discussed in Chipman et al. (1978).

Data Processing and Organization

As noted earlier, a large amount of data is required to support the Gotz model. For each pay grade and LOS, estimates must be made of (1) military and civilian pay opportunities and (2) promotion and involuntary separation probabilities. Also, the parameters of any military compensation system, such as retirement or severance pay multipliers, must be known. To better estimate the relationship between the COLs and voluntary retention rates, data for 2 years (FY76 and FY77) were collected.

Military pay was determined by using basic rates contained in the Navy Regular Military Compensation (RMC) tables for FY76 and FY77, plus the average incentive pay. Civilian pay was determined by using the figures shown in Table 1 for FY76 and by inflating these figures by a factor of 7.1 percent for FY77. It was assumed that enlisted personnel enter the Navy at age 19, which implies that those in LOS cell 1 would be able to obtain a civilian job that would pay, on the average, the amount of money earned by a 20-year old high school graduate.

Table 1

Average Civilian Income by Age for High School Graduates
(1975 Dollars)

Age	Income	Age	Income	Age	Income
20	8934	35	15632	50	17443
21	9551	36	15878	51	17408
22	10169	37	16125	52	17374
23	10786	38	16170	53	17153
24	11403	39	16216	54	16933
25	12020	40	16261	55	16711
26	12637	41	16311	56	16491
27	13254	42	16356	57	16270
28	13581	43	16594	58	16286
29	13910	44	16832	59	16304
30	14237	45	17071	60	16321
31	14565	46	17308	61	16339
32	14893	47	17547	62	16356
33	15139	48	17513	63	16356
34	15385	49	17478	64	16356

Note. Data from Warner, J. T. Analysis of the retention impact of the proposed retirement system, April 1978.

To compute the promotion and involuntary separation probabilities, yearly summaries of all enlisted personnel actions were obtained for FY76 and FY77. These actions were classified into such categories as ineligibles, total attrition, nonreenlistments, continued service/broken service, and miscellaneous gains. Manipulation of those groups not only permitted the computation of the required flow probabilities, but also other necessary statistics. This included (1) the proportion of "deciders" by LOS (e.g., the proportion of personnel eligible to make a reenlistment/nonreenlistment decision), (2) the

voluntary retention rates for the "deciders" by LOS and pay grade, and (3) the distribution of deciders across the nine pay grades for each LOS cell. The method used in performing these calculations is summarized in Appendix A.

Analytical Results

Using the data obtained for FY76 and FY77, the COLs for 279 cells (9 x 31) for each year were produced by the Gotz dynamic programming model. The average of these two sets of numbers is presented in Table 2. To illustrate this output, the COLs computed (by using the average of the FY76 and FY77 promotion and separation probabilities) for the current retirement system and the proposed President's Commission on Military Compensation (PCMC) retirement system are presented in Figure 1. COLs are presented for LOS cells 1-31, with the pay grade for each LOS cell being determined by the average time-in-service at promotion. The main feature to note is the wide range of COLs that occurs under the current system, which, in turn, produces large differences when compared with other retirement systems providing radically different pay schemes (such as PCMC). The goal of the analysis, then, is to determine one or more models that will forecast voluntary retention rates by pay grade and LOS, given a particular COL (read retirement system).

To forecast future retention behavior, given a set of economic incentives, current behavior must somehow be related to current incentives. Thus, the current voluntary retention rates were computed (see Appendix B) and plotted against current COLs for FY76 and FY77. Results are provided in Figure 2. The curvilinear relationship in these data is readily apparent, with retention rates increasing as the COL increases. LOS is another variable that could possibly predict behavior. The relationship between LOS and retention rates, plotted in Figure 3, appears to be positive up through LOS cell 19 and unclear thereafter.

In establishing the final prediction models, the authors proceeded through several stages of analysis. As a first step, upon examination of Figure 2, three models were proposed as being characteristic of the observed COL-retention rate relationship. These models (where r = voluntary retention rate and X = COL) are: (1) a quadratic relationship, $r^2 = b_0 + b_1X$, (2) an exponential model $r = 1 - e^{-b_0-b_1X}$, and (3) a logit function, $r = 1/(1 + e^{-b_0-b_1X})$. Analysis revealed that models (2) and (3) were superior to (1) and had very little difference in the goodness of fit between them. However, the logit function (described in Theil, 1971) was selected as the final form of the prediction model due to its property of restricting predicted values to lie between 0 and 1, the same bounds for retention rates.

Once the final form of the model was set, the inclusion of LOS as another explanatory variable was considered. Originally, a predictive relationship based upon only COL was considered sufficient. However, because COL is only representative of some of the economic factors involved in the decision to stay or leave, it was thought that LOS, a possible surrogate for the other economic and non-economic factors, could explain additional variance in the retention rates. This proved to be the case as both COL, LOS, and an interaction term, COL*LOS, were significant in the fitted model, namely:

Table 2

Average (FY76-77) Costs of Leaving
for Current Retirement System
(In Dollars)

LOS	E-1	E-2	E-3	E-4	E-5	E-6	E-7	E-8	E-9
1	-2341	-1742	-1758	-1331	-1008	- 87	1883	16771	39008
2	-1690	-2136	-1772	-1622	-1175	- 201	1108	14038	35936
3	-1835	-1779	-1893	-1759	-1373	- 570	339	11736	33261
4	-2142	-1794	-1673	-1901	-1133	- 948	- 36	9907	31021
5	-2452	-2446	-2694	-2645	-2323	-1358	- 674	8598	29260
6	-2761	-2811	-3829	-2975	-2500	-1689	-1035	7861	28026
7	-3070	-3175	-3800	-3458	-3119	-2456	-1674	7753	27371
8	-3234	-3369	-3772	-3629	-3133	-2519	-1753	8337	27353
9	-3399	-3563	-4508	-4020	-3494	-2668	- 300	9351	27706
10	-3563	-3757	-4751	-4180	-3121	-1299	1973	10842	28469
11	-3727	-3950	-4966	-3554	-1628	1444	4926	12601	29681
12	-3891	-4144	-4654	-1328	1418	4882	8508	14909	31388
13	-4015	-4290	-3584	1320	4756	8579	12428	17507	33639
14	-4138	-4355	-2219	4170	8460	12854	16826	20644	36395
15	-4262	-3352	209	7539	12506	17429	21918	26430	39388
16	-4348	-2086	3203	11398	17087	22634	27648	32635	42961
17	-2929	85	6852	16075	22120	28336	33807	39595	46835
18	- 4	3650	11635	21447	28284	34728	40654	47106	54319
19	6819	10349	18631	27467	35031	41758	47800	54929	62351
20	-4444	-4245	-5871	-3274	-3620	-4949	-3964	-1377	-1713
21	-4553	-4340	-5988	-3324	-4515	-5127	-4952	-2586	-2907
22	-4672	-4444	-6109	-3378	-4532	-4668	- 984	952	671
23	-4902	-4677	-6404	-3623	-5230	-5145	-5524	-3804	-4031
24	-5147	-4925	-6708	-3878	-3570	-5358	-3677	2	- 730
25	-5409	-5191	-7023	-4145	-5168	-3933	2862	4867	4426
26	-5691	-5475	-7348	-4421	-6482	-5586	-6787	-4984	-5149
27	-5995	-5783	-7688	-4713	-9513	-5322	-7303	-5487	-5814
28	-6187	-5953	-7810	-4761	-9208	-6300	-7838	-6467	-6228
29	-6407	-6151	-7947	-4826	-5872	-7335	-8144	-6860	-6663
30	-7179	-7080	-9249	-6427	-7871	-10831	-10757	-9693	-10621
31	-7184	-7095	-9256	-6470	-7891	-9954	-11300	-10532	-10469

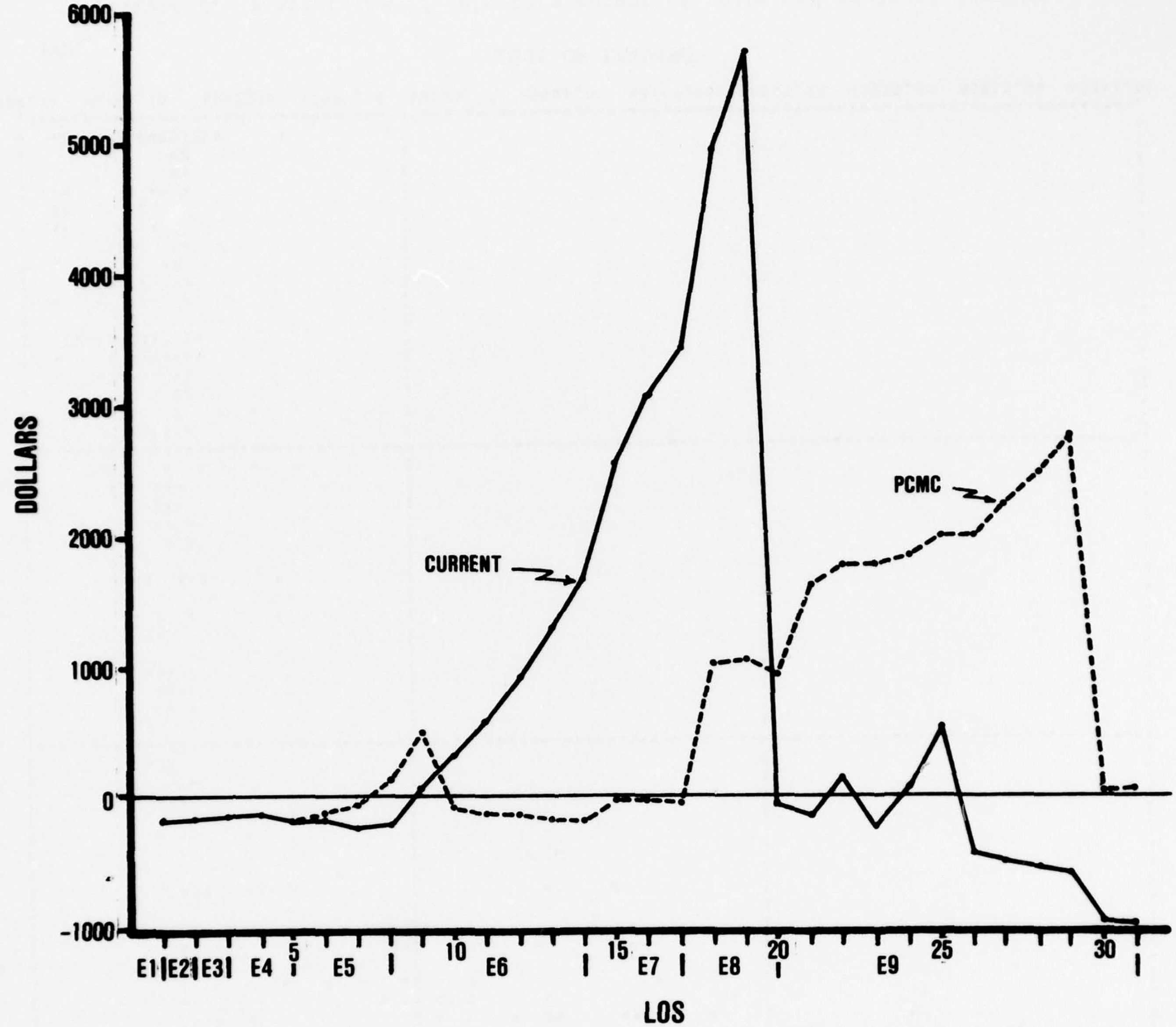

Figure 1. Costs of leaving for current system and proposed PCMC system.

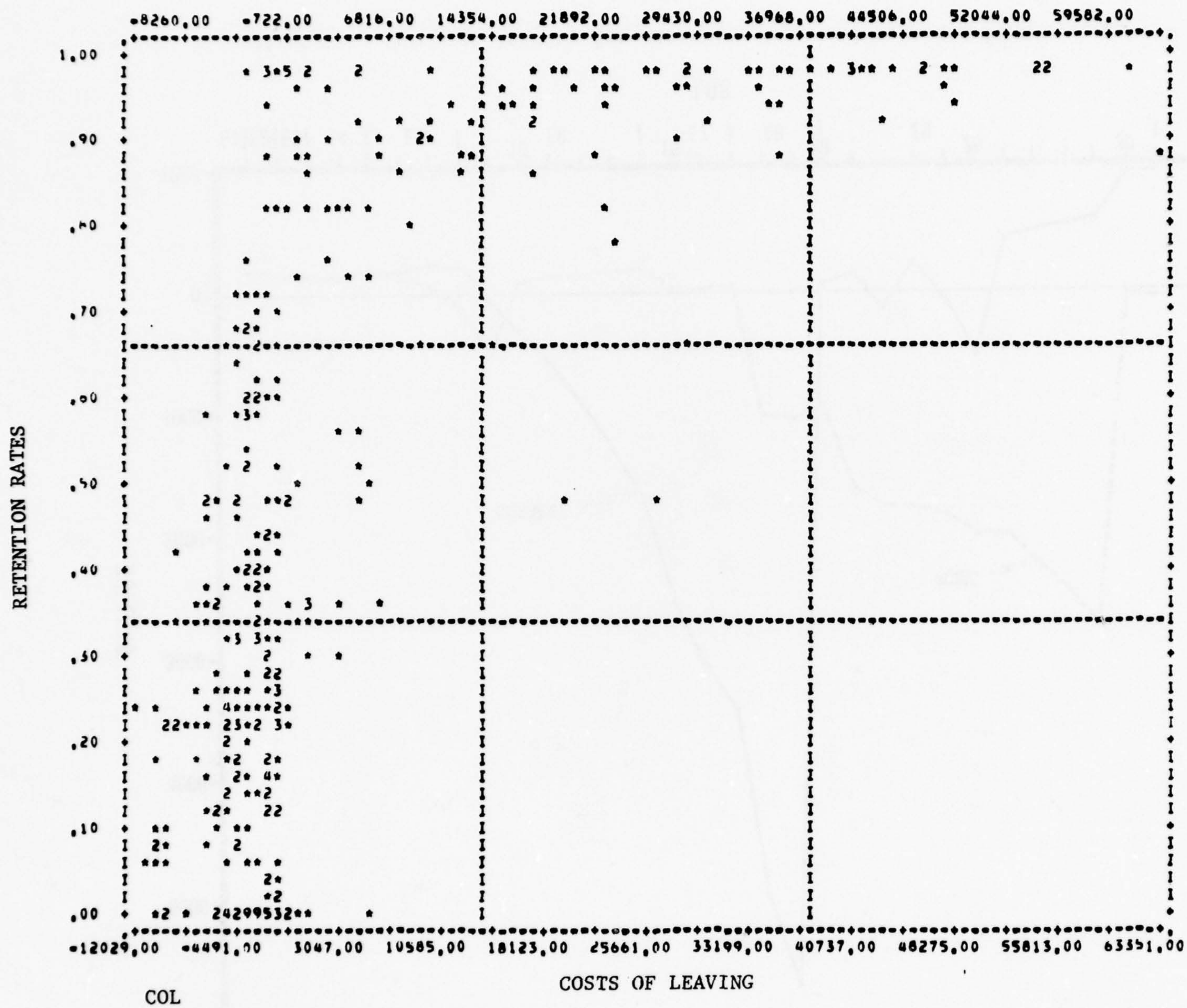

Figure 2. Scattergram of voluntary retention rates and costs of leaving.

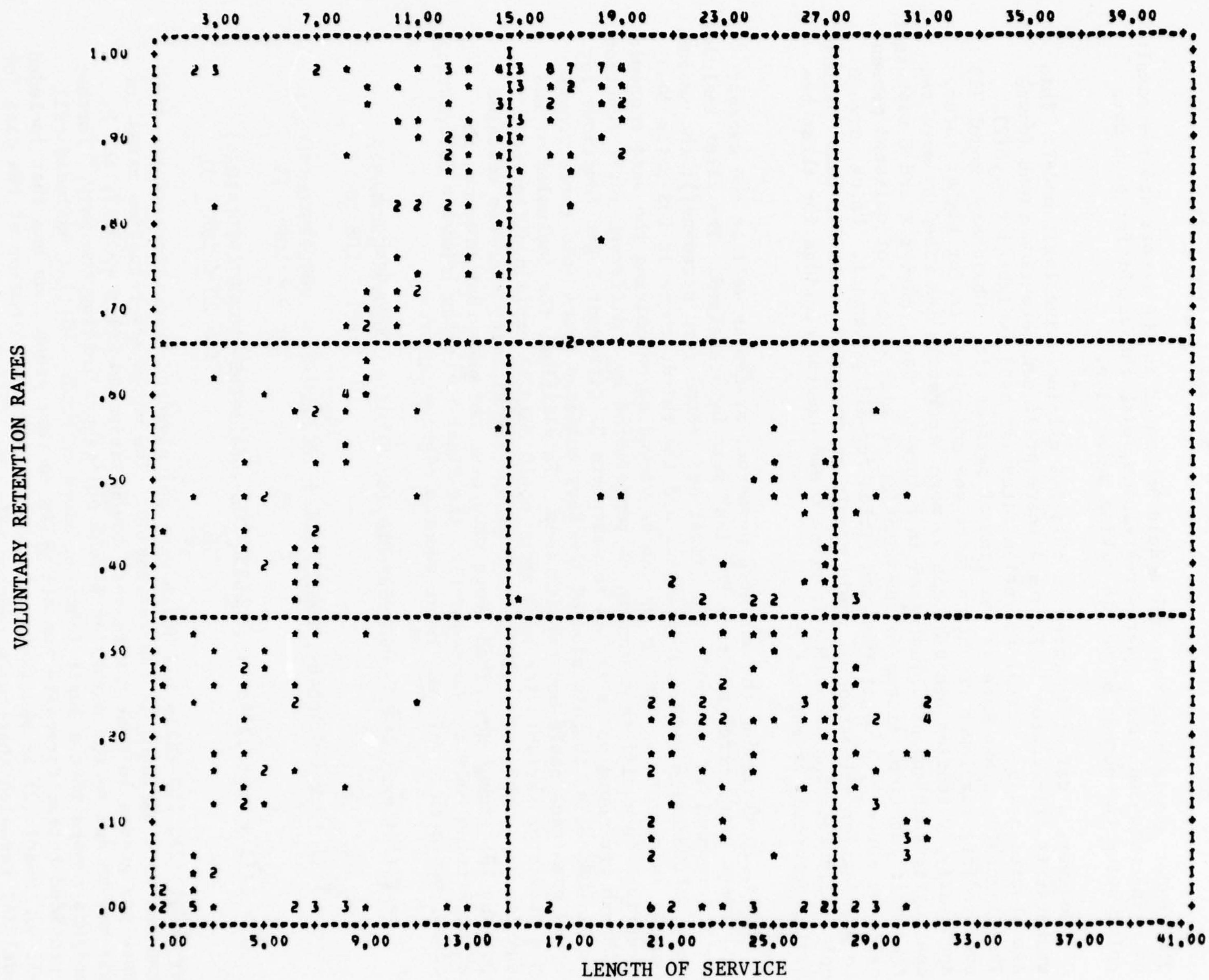

Figure 3. Scattergram of voluntary retention rates and length of service.

$$r = 1/(1 + \exp(-1.52173 - .00043*COL + .09129*LOS + .00002*LOS*COL)) \quad \text{for } 1 \le LOS \le 31 \tag{1}$$

The reader should note that all models presented in the report are the result of using weighted least squares regression, with the weight for each data point being the number of people making a decision.

However, a defect appeared in this LOS all-inclusive logit model. This weakness is illustrated in Figure 4 where predicted retention rates (down) are plotted against actual retention rates (across) (weighted r = .612). The diagonally drawn line is the line of perfect fit. Obviously, model (1) overpredicts for lower retention rates and underpredicts for higher rates. Apparently, retention behavior can be more accurately described by more than one logit function, as illustrated in Figure 5. Here, curves A and C represent the logit functions fitted to the behavior of some subsets of enlisted personnel; and curve B, a logit function fitted for all personnel. Using curve B to predict for all personnel would result in overpredictions for those personnel really behaving according to curve C and underpredictions for those behaving according to curve A.

Thus, in reviewing the enlisted personnel system as well as the current retirement plan, three separate "Navies" were hypothesized. The first includes those personnel in LOS cells 1-8 (first and second term personnel); the second, those in LOS cells 9-19 (careerists); and the third, those in LOS cells 20-31 (senior careerists). Each group can be viewed as perceiving the same economic incentives in a different manner, as represented by a different logit function. Although one could go as far as to postulate 31 different logit functions for the 31 LOS cells, the division of the Navy enlisted force into three groups seemed both reasonable and parsimonious. In addition, the inclusion of LOS as a predictor variable for each group would help to explain differences in behavior among LOS cells within each group. Sensitivity analysis revealed that the LOS groups described above were also the ones that produced the better-fitting models. Consequently, the final retention behavior forecasting models, based on a weighted least squares regression are:

$$r = 1/(1 + \exp(.24430 - .0009962*COL - .16005*LOS + .0000998*COL*LOS)) \quad \text{for } 1 \le LOS \le 8 \tag{2}$$

$$r = 1/(1 + \exp(-3.46546 - .0003538*COL + .20232*LOS + .0000129*COL*LOS)) \quad \text{for } 9 \le LOS \le 19 \tag{3}$$

$$r = 1/(1 + \exp(2.20967 + .0000750*COL - .06475*LOS - .0000074*COL*LOS)) \quad \text{for } 20 \le LOS \le 31 \tag{4}$$

For model (2), LOS cells 1-3 and 6 were perceived to be outliers in the data base and were excluded in the regression. The voluntary retention rates for those pay grades in cell 6 were very low relative to cells 4, 5, 7, and 8. This may be due to the number of 6-year obligators leaving the Navy. Further analysis showed that a logit function based on cells 4-8 that excluded cell 6 provided better forecasts for all cells in that group than one that included cell 6. Model (2) is precisely this model. Also, examination of the data for model (4) revealed that the retention rates for cell 20 took extreme values due to the mass exit of careerists. Hence these points were eliminated from the regression, and the result is seen in (4).

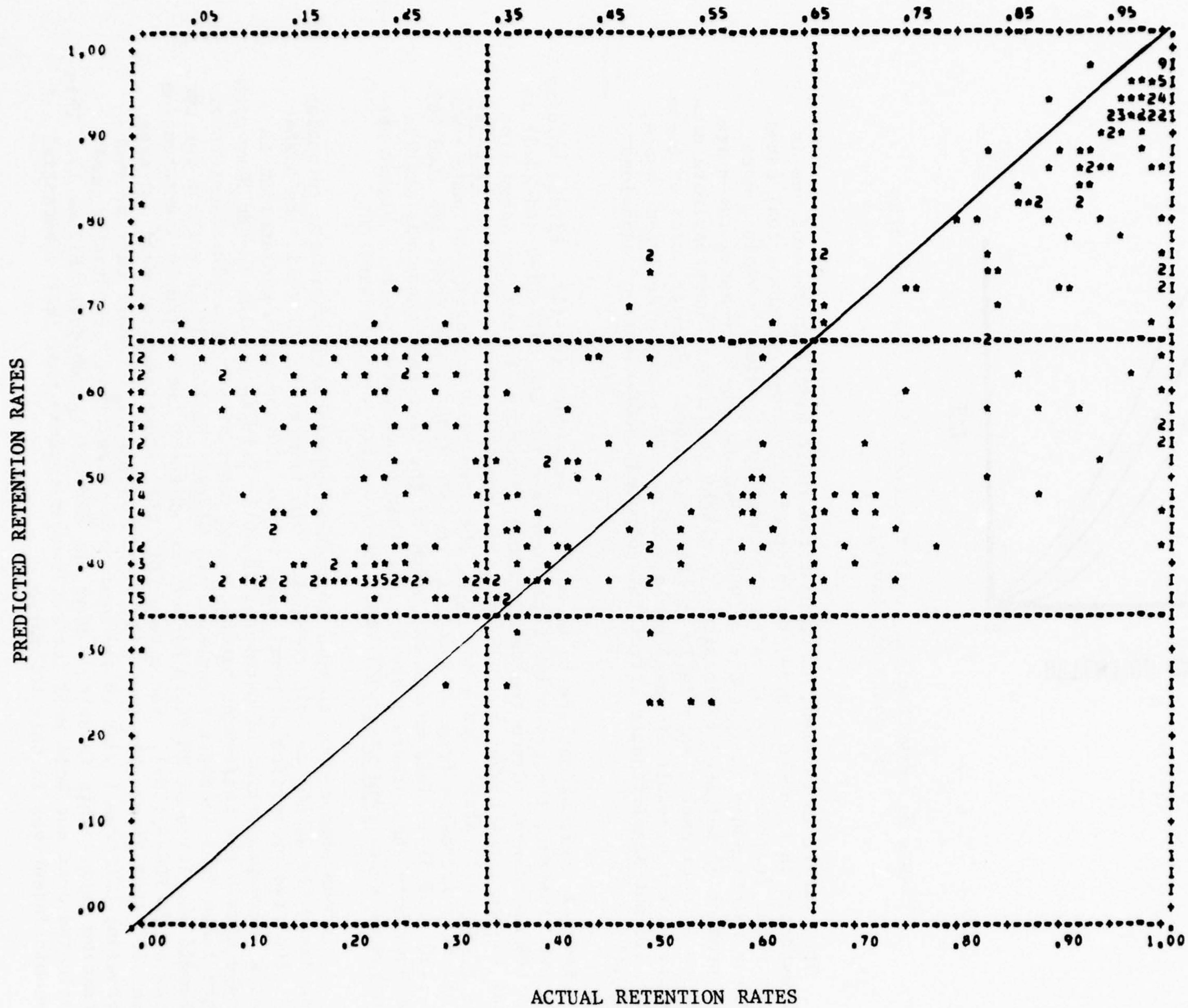

Figure 4. Plot of predicted and actual retention rates for one logit model.

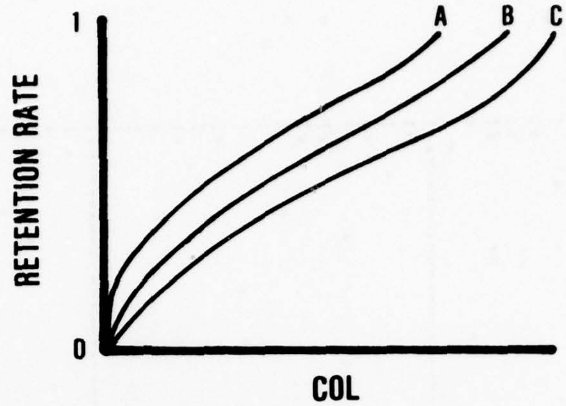

Figure 5. Hypothetical logit functions for retention rates vs. costs of leaving.

The overall improvement in using three logit models instead of one is illustrated in Figure 6. Here, the plot of forecasted versus actual retention rates (review Figure 4) using all three logit models reveals a more linear relationship (weighted r = .930). Because the forecasted rates are the product of weighted regressions, a slight tendency to underestimate some points is noticeable, especially in the .4-.7 range. However, many of these points were the result of small numbers of people making a decision; hence, they did not significantly affect the computed coefficients of equations (2)-(4).

Several implications are to be noted in equations (2)-(4). First, holding the COL constant, the retention rate increases for LOS cells 1-8 and 20-31 as the LOS increases. Given the same economic incentive to stay or leave from year to year, the higher the LOS cell, the more likely that persons in these two groups will stay. For a zero COL, the predicted proportion of people who would stay increases from .405 (LOS 1) to .676 (LOS 8) and from .286 (LOS 20) to .450 (LOS 31). This may be explained by the fact that those who dislike the Navy more than others leave earlier than others; therefore, a higher percentage of those remaining will stay, given a zero (or constant) COL.

A curious phenomenon, though, is seen in equation (3) where the retention rate decreases as COL is held constant. The higher the LOS cell, the higher the predicted proportion of people who leave. One possible explanation is that a large proportion of personnel in cells 9-19 is staying in the Navy with an eye toward the retirement benefit at 20 years of service. These personnel might leave (and in greater numbers, the higher the LOS) if it weren't for the economic incentive at 20 years of service (witness the extremely low retention rates at 20 YOS--.1305). For a zero COL, the retention rate would decrease from .685 (LOS 9) to .224 (LOS 19). For this group, it would take an ever-increasing COL from 1 year to the next just to maintain a constant annual retention rate. This is exactly what the current system does (Figure 1). This conclusion does not bode well for retirement systems that lack substantial economic incentives in this LOS range.

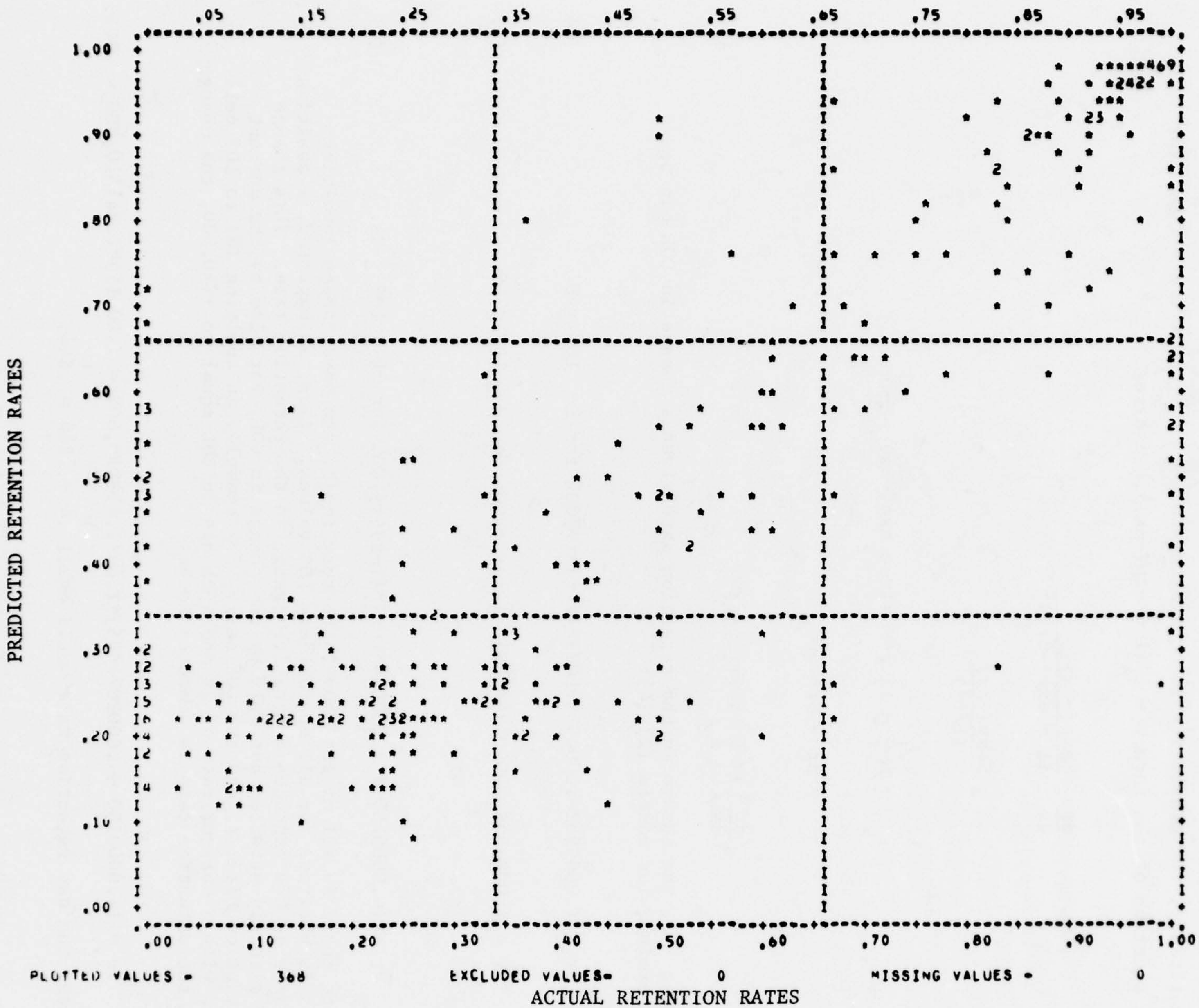

Figure 6. Plot of predicted and actual retention rates for three logit models.

Another factor to be considered in (2)-(4) is the elasticity of the retention rate with respect to COL. That is, given a percent change in the COL, the elasticity yields the percent change in the retention rate. Mathematically, the elasticity is equivalent to $\left(\frac{dr}{dx}\right) / \left(\frac{r}{x}\right)$ where x = COL. For an equation of the form $r = 1/(1 + \exp(-\beta x))$, we have

$$\frac{dr}{dx} = \frac{\beta \exp(-\beta x)}{(1 + \exp(-\beta x))^2}$$

$$= \frac{\beta \exp(-\beta x)}{(1/r^2)}$$

$$= \beta\left(\frac{1}{r} - 1\right) r^2 \quad \text{since } \exp(-\beta x) = \frac{1}{r} - 1$$

$$= \beta r - \beta r^2 \text{ and}$$

$$\left(\frac{dr}{dx}\right) / \left(\frac{r}{x}\right) = \beta(1-r)x. \tag{5}$$

Using (5), the change in the retention rate given a change in COL can be determined for models (2)-(4):

$$\overline{V}r = (.0009962-.0000998*LOS)*(1-r)*r*\overline{V}COL \text{ for } 1 \leq LOS \leq 8 \tag{6}$$

$$\overline{V}r = (.0003538-.0000129*LOS)*(1-r)*r*\overline{V}COL \text{ for } 9 \leq LOS \leq 19 \tag{7}$$

and

$$\overline{V}r = (-.0000750 + .0000074*LOS)*(1-r)*r*\overline{V}COL \text{ for } 20 \leq LOS \leq 31. \tag{8}$$

Note that, in all of the above, the term inside the parentheses involving LOS is positive for all appropriate LOS values. Thus, as expected, a positive change in COL produces a positive change in the retention rate. This change is directly affected not only by the change in COL, but also by the current retention rate, r, and the LOS cell. For example, in applying (8) to LOS cell 25, with a current rate of .4 and a change in COL equal to +\$10,000, the change in the retention rate is computed to be

$$\overline{V}r = (-.0000750 + .0000074*25)*(.6)*(.4)*\$10,000 = (.00011)*(.24)*10,000 = .264.$$

Thus, the new retention rate would equal .4 + .264 = .664.

Obviously, equations (6) through (8) can be used to provide estimates of how much additional money (e.g., bonus) would be required to increase a retention rate by a desired amount. The amount of money, though, will vary according to each individual LOS cell. Suppose, for example, that a change of +.25 is desired in the current retention rates for LOS cell 5, and that the current rate for cell 5 is .5. Then, solving (6) for $\overline{V}$COL, the value $2011 is obtained. The "bonuses" required to produce a similar type of change for all LOS cells is depicted in Figure 7. Here, the additional amounts of money required to raise current retention rates by 10 percent are plotted. For LOS cells 14-19, the amounts of money necessary to raise the rates to 1.0 are calculated instead. Particularly noticeable is the steady climb in bonus money for cells 9-19. This is due to the fact that personnel who leave in these cells, particularly those nearer to cell 20, are leaving for reasons other than money (since retirement pay is just around the corner). Hence, larger amounts of money are required to overcome these reasons. Given the COLs for a proposed retirement system and the desired and current retention rates, this type of procedure can be applied to determine the amounts of additional money (on top of the incentives of the proposed system) necessary to achieve the desired retention rate.

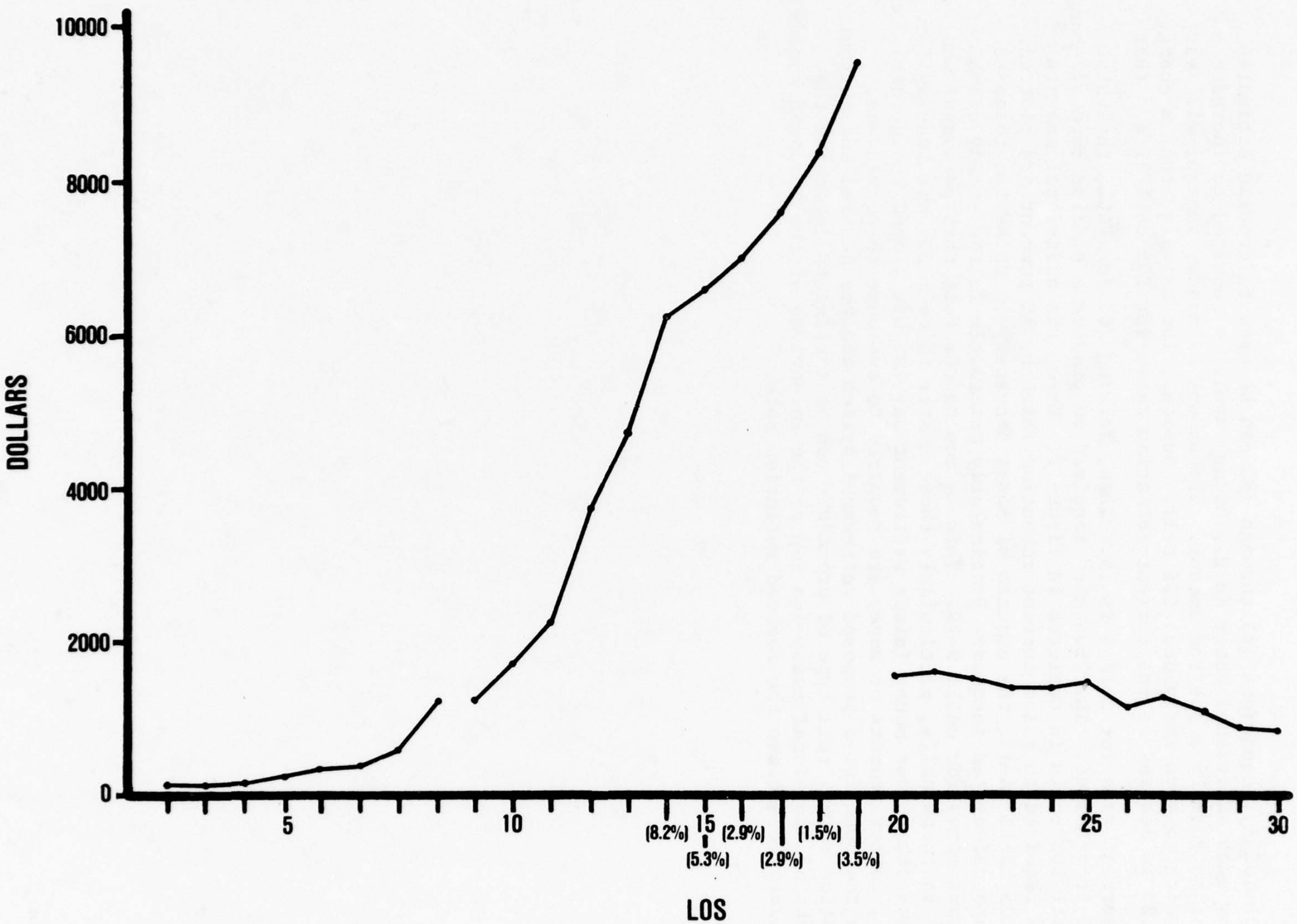

Figure 7. Amount of "bonus" money required to raise current retention rates by 10% (or to 1.0 for LOS cells 14-19).

RESULTS

This section presents numerous results emanating from the logit functions developed in the previous section. First, a general description of the continuation rate forecasting model is given. Next, a validation of the logit functions as predictors of the current system's retention and continuation rates is detailed. Also, use of the model is made in forecasting retention and continuation rates under the PCMC and DoD proposed retirement systems, which vary as to discounting factor, severance probabilities, and civilian earnings.

Continuation Rate Forecasting Model

Although equations (2) through (4) provide predictions of retention rates for each individual pay grade/LOS cell, these rates must, in turn, be translated to LOS continuation rates. This procedure is accomplished in two simple steps requiring the use of two sets of data.

First, after all 279 (9 x 31) predictions are made, a combined retention rate for each LOS cell is computed by applying a set of pay grade weights to the nine predictions relevant to each LOS cell. The method involved in determining these rates is described in Appendix A. Also listed there are the actual weights, which are based on the number of personnel, by pay grade, eligible to make a stay/leave decision.

Once the voluntary retention rates are known for each LOS cell, they must be blended into the continuation rates for those people not making a decision; that is, the "nondeciders." One set of data, then, is the proportion of deciders and nondeciders for each LOS cell. The actual proportions and the method for determining them are detailed in Appendix B. The only other factors requiring definition are the continuation rates for the nondeciders. Due to such occurrences as death, desertion, and court martial, these rates should be less than 1. They were derived from the following equation:

$$V_j * PV_j + IV_j * (1. - PV_j) = C_j \qquad \text{for } j = 1,\ldots,31 \tag{9}$$

where

V_j = Voluntary retention rate for LOS cell j,

PV_j = Proportion of deciders,

IV_j = Continuation rate for nondeciders, and

C_j = Current LOS (computed by Pay Entry Base Date (PEBD)) continuation rate.

Since all other variables are known, the continuation rates for nondeciders (IV_j's) can easily be determined. These rates are provided in Table 3, which shows that the rates for personnel in cells 2-4, where first-term attrition is high, are relatively lower than those for personnel in other cells.

Table 3

Continuation Rates for Nondeciders

LOS	Rate	LOS	Rate	LOS	Rate	LOS	Rate
1	1.0355[a]	9	.9982	17	.9898	25	.9996
2	.8251	10	.9985	18	.9877	26	.9873
3	.7770	11	.9980	19	.9975	27	.9995
4	.7374	12	.9940	20	.9943	28	.9994
5	.9724	13	.9934	21	.9904	29	.9424
6	1.1389[a]	14	.9871	22	.9869	30	.9945
7	.9783	15	.9918	23	.9901	31	.9945
8	.9843	16	.9890	24	.9967		

[a]May reflect external entries into LOS cell.

The LOS cell voluntary retention rates (V_j's), proportions of deciders (PV_j's) and current LOS continuation rates (C_j's) in equation (9) were all derived from the average of FY76 and FY77 data. Thus, in the continuation rate forecasting model, the V_j's are supplied by the logit functions (2) through (4), the PV_j's and IV_j's are known, and equation (9) is applied to yield predictions of ALNAV LOS continuation rates--the C_j's. Note that these continuation rates result from service computed by Pay Entry Base Date (PEBD) and, therefore, credit individuals with service beyond that of active duty alone. PEBD is, of course, most appropriate for costing purposes. An interactive computer program known as Retirement Analysis Model II (RAM II) provides predictions of the voluntary retention rates (V_j's) and the continuation rates (C_j's) by LOS for virtually any type of retirement system. The user need only reply to the RAM II prompts requesting the parameters of the retirement system. All other data is built into the program. By altering the retirement system parameters from one run to the next, the user can easily perform sensitivity analysis on how the retention and continuation rates vary as the parameters vary. The quick response time allows for the analysis of many alternative systems within a relatively short period of time. RAM II is currently operational on a UNIVAC 1110 at Naval Ocean Systems Center, San Diego under a NAVPERSRANDCEN account.

Obviously, many analyses employing the use of the forecasted continuation rates can be made. One can calculate the steady state force, given the continuation rates, and from that compute the expected number of accessions, careerists, retirees, etc. Expected costs, including many types of active duty and retirement costs, can be calculated. The effects of transiting from the current

system to a proposed system can also be examined. All of these analyses and others are performed interactively through the use of RAM I (see Chipman, Silverman, & Willis, 1978). Thus, RAM II not only serves a useful purpose as a stand-alone model, but also serves as the supplier of continuation rates to RAM I.

Validation of RAM II for the Current System

RAM II was used to predict retention and continuation rates for the current system. Recall that the current system contains no provisions for severance benefits, trust funds, or social security offsets. Retirement pay is .025*(years of completed service)*(final annual basic pay) for those with 20 or more years of service (YOS). The benefits are received immediately upon retirement. The actual and predicted retention and continuation rates for the current system are given in Appendix B (Table B-1), with the voluntary retention rates being plotted in Figure 8. The actual rates are the average of FY76 and FY77.

Two of the largest discrepancies occur for cells 6 and 20 where the model is unable to capture the retention behavior of personnel, suggesting noneconomic factors in the decision to leave the Navy. Of course, these were two of the cells omitted in the final determination of the logit functions (2) through (4). The retention rates for cells 27 and 28 were severely underestimated, indicating a relatively stronger desire to remain in the Navy, given a relatively lower COL. In these cells, of course, the numbers are very small and therefore more difficult to capture in a model. Otherwise, the fit of the predicted rates with the actual rates seems quite good, the average absolute error for all cells being only .0358.

Predictions for PCMC and DoD Retirement Systems

Two of the most frequently discussed retirement system alternatives are those suggested by the President's Commission on Military Compensation (1978) and the Assistant Secretary of Defense (White, Note 2). The parameters for these two systems, as well as those for the current system, are included in Table 4.

There are two primary differences between the PCMC and DoD plans. The first involves the retirement annuity computations. For 10 to 19 and 20 to 29 completed years of service (YOS), the DoD plan begins paying benefits 3 years earlier than the PCMC plan. The retirement multipliers are identical for 10 to 30 YOS; however, the DoD plan does not increase the multiplier past 30 YOS as the PCMC plan does. For DoD, the annuity is based on a "high 2" average basic pay instead of a "high 3" average under PCMC. The second major difference is in the trust fund arrangements. Not only are the government contribution percentages different, but also the amount of the fund one is entitled for 10-14 YOS. However, perhaps the most important feature is that DoD explicitly allows a person on active duty to withdraw up to 50 percent of the vested amount in the accumulated trust fund. DoD views the fund, then, as a type of supplemental active duty income, whereas the PCMC perceives it more as a lump sum payment upon discharge to aid in the transition to civilian life.

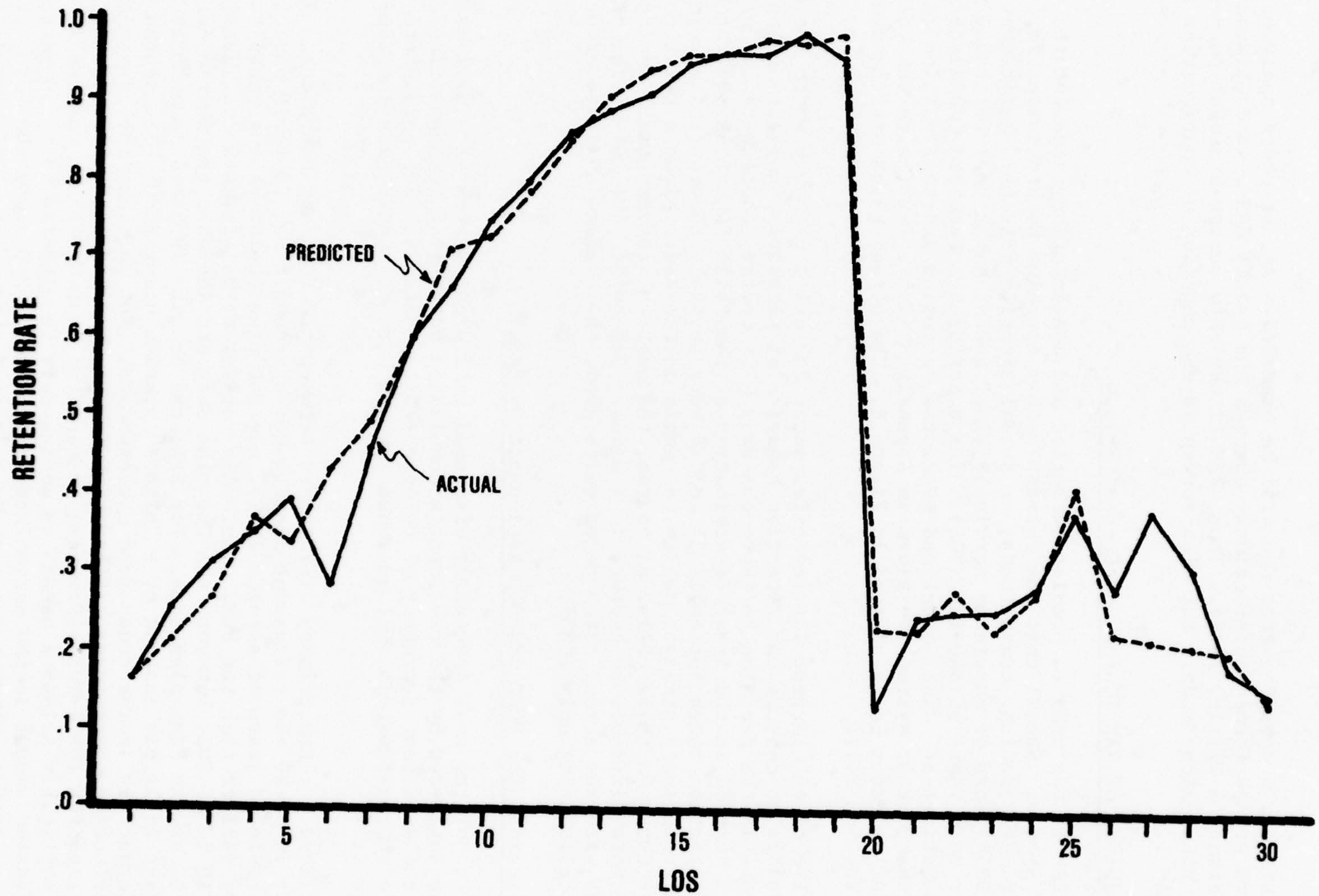

Figure 8. Actual and predicted voluntary retention rates for current retirement system.

Table 4

Retirement System Parameters for Current, PCMC, DoD Systems
(Enlisted Personnel Only)

Item	Current	System PCMC	DoD
Retirement eligibility age at which annuity begins	Immediately for 20+ YOS 55 (30+ YOS)	62 (10-19 YOS) 60 (20-29 YOS) 55 (26+ YOS)	59 (10-19 YOS) 57 (20-25 YOS)
Computation of annuity	2.5% for each YOS up to 30 (Final Basic Pay)	2% for YOS 1-5 2.25% for YOS 6-10 2.75% for YOS 11-35 (High 3 Average Basic Pay)	2% for YOS 1-5 2.25% for YOS 6-10 2.75% for YOS 11-30 0% for YOS 31+ (High 2 Average Basic Pay)
Social Security Offset (Retired pay reduced for social security entitlement)	None	Yes (See President's Commission on Military Compensation, 1978, for details)	Yes (See White, Note 2, for details)
Trust Fund: Government contributions (% of Basic Pay)	None	20% for YOS 6-10 25% for YOS 11-20 15% for YOS 21-25 5% for YOS 26-30	15% for YOS 6-10 40% for YOS 11-20 5% for YOS 21-25 0% for YOS 26+
Amount of trust fund vested	None	100% for 10+ YOS	50% for 10 YOS 60% for 11 YOS 70% for 12 YOS 80% for 13 YOS 90% for 14 YOS 100% for 15+ YOS
Amount of vested accumulated trust fund that can be withdrawn while on active duty	None	Modelled as 0% (Used as assistance for transition to civilian life)	50%
Severance Pay	None	1/4 month basic pay for each YOS between 1-10. 1/2 month basic pay for each YOS between 11-30. May not exceed 1 year's basic pay.	Undecided (Modelled the same as PCMC's, however.)

The forecast retention and continuation rates for the DoD, PCMC, and current systems are presented in Table B-2, Appendix B. The voluntary retention rates for the three systems are plotted in Figure 9. It should be noted that, in predicting the continuation rates for alternative retirement systems, the proportions of people eligible to make a decision have been set to 25 percent for LOS cells 9-31 (the PV_j's in equation (9)). The explanation is that alternative systems not only produce changes in retention behavior, but also changes in the way in which enlisted personnel reenlist or extend their contracts. For example, the large proportion for cell 20 would most likely be lowered under the PCMC or DoD plan. It is therefore assumed that one of every four persons in LOS cells 9-31 will reach the end of his/her active obligated service. The pattern of decision-makers is assumed to remain unchanged for first- and second-term personnel.

The effects of the incentives offered by the PCMC and DoD plans are readily observable. First, the establishment of a trust fund apparently raises retention rates in LOS cells 1-9 for both systems. However, DoD's dangling carrot, in the form of increasing vesting percentages, also raises rates for that system for cells 10-12. The rates are lower for the teen LOS cells since neither system offers a large retirement incentive at 20 YOS. However, the retention rates in these cells for the DoD plan are substantially larger than those for the PCMC plan. This is due to the size of the government contributions, as well as the capability of being able to withdraw from the trust fund while on active duty. For 20-30 YOS, the rates for both systems are higher than the current system's rates. PCMC's rates are higher than DoD's for cells 24-30 since (1) the government contributes more to the trust fund under the PCMC plan in that range and (2) there is a stronger pull to 30 YOS due to the significant lowering of the age at which retirement benefits begin (from 60 to 55 at 30 YOS).

Sensitivity Analysis

There are many data requirements underlying the dynamic programming approach. Two of the more important ones include the involuntary separation probabilities and the amount of civilian earnings available to Navy enlisted personnel. Different assumptions regarding these parameters will obviously affect the COLs, which, in turn, will lead to different rate forecasts. The prediction of rates for the DoD plan given in Table B-2 are used as a base case for performing a sensitivity analysis on the two parameters listed above. Two alternative assumptions for each parameter are given. These sensitivity analysis results are based on equations (2) through (4) using the COLs generated by the alternative parameter values. Different results would occur if one were to fit a whole new set of logit functions to the new COLs and then produce predictions from those equations instead of (2) through (4). The primary assumption here is that enlisted behavior is adequately modelled by these equations and, thus, changes in the COLs stemming from changes in the parameters will produce changes in behavior according to them.

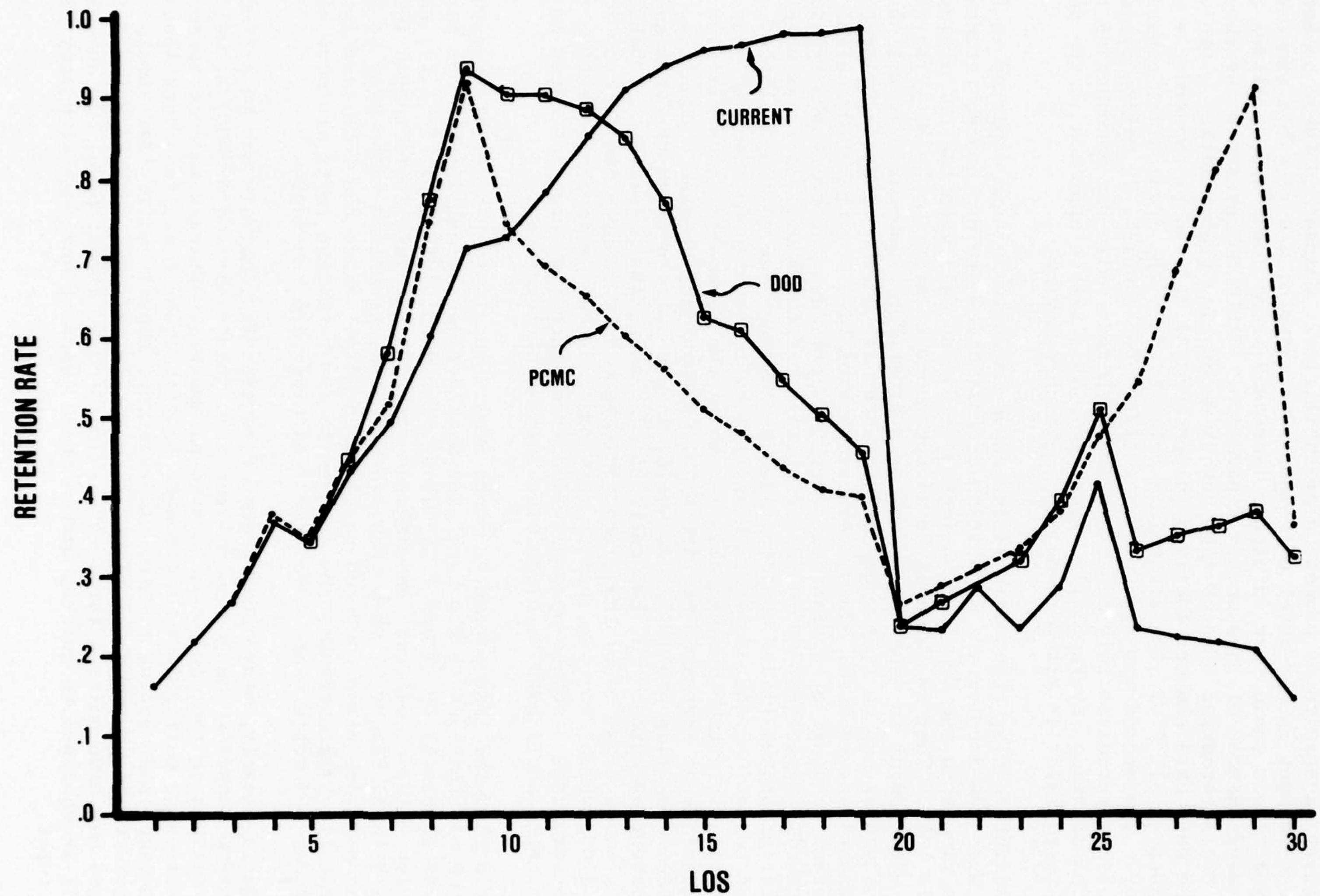

Figure 9. Predicted voluntary retention rates for current, PCMC, DoD retirement systems.

One set of parameters that one might want to vary is that of the involuntary separation or promotion probabilities. Changes in these numbers may reflect changes in personnel policies. For example, a noticeable shortage of petty officers could lead to either increased promotional opportunities or decreased chances of involuntary separation. Table B-3 presents the results from two alternative sets of involuntary separation probabilities. One consists of the base case numbers (derived in Appendix A) divided by two and the other consists of all 0's. The first is a relaxation of the involuntary separation policy. The second may apply to an enlisted force which, in making optimal decisions, perceives only its promotional chances while not considering the chances of being involuntarily separated. This latter approach is the one taken by Warner (1978) in his work on continuation behavior.

An interesting phenomenon is indicated in Table B-3 and depicted in Figure 10. When the involuntary separation probabilities are decreased, retention rates rise when the COL is high (cells 5-15) and fall when the COL is low (cells 1-4). That is, when it is advantageous to stay in the Navy (particularly when entitlement to a benefit, such as a trust fund, is near), it will be even more advantageous to stay when one's chances of being separated (prior to entitlement) are reduced. Thus, retention rates rise for these LOS cells. On the other hand, if a substantial benefit is provided for those who are involuntarily separated (as in the DoD plan), the COL's will decrease when the separation probabilities are decreased because one can no longer "hope" or expect to collect that separation benefit by staying in for another year. This is particularly true during cells 1-4 where the separation probabilities and expectations of severance pay are high. Without any severance benefits, lowering the separation probabilities would, in general, increase the COLs and thus the retention rates. For LOS cells 16 and above, the separation probabilities were already close to 0; thus, lowering these only changed the COLs by less than $100, which, in turn, led to very small decreases in the retention rates. If no severance benefits were provided, the change in retention rates in those cells would have been positive instead of negative.

Finally, the last parameter to be considered is that of civilian earnings. The two alternatives to the base case were derived by multiplying the base case figures (Table 1) by .9 and 1.1. Thus, with a multiplier of .9 (1.1), the relative value of military earnings to civilian earnings is increased (decreased). Table B-4 and Figure 11 show that, as expected, retention rates rise as the value of the military rises compared to civilian life. Since the COLs take into account lifetime earnings, the changes in the retention rates are more severe for lower LOS cells since more years' earnings are considered.

Quite clearly, many other types of sensitivity analysis may be performed. One might consider changes in military pay (basic pay and/or RMC) as well as alternatives to the retirement system parameters. Changes in such parameters as retirement multipliers, retirement benefit ages, trust fund contribution percentages and vesting rights, and severance benefit multipliers would all lead to different predictions of retention and continuation rates. Some changes may have quite a large effect and others, almost none. In any case, RAM II is equipped to quickly handle these types of analyses with very little user input.

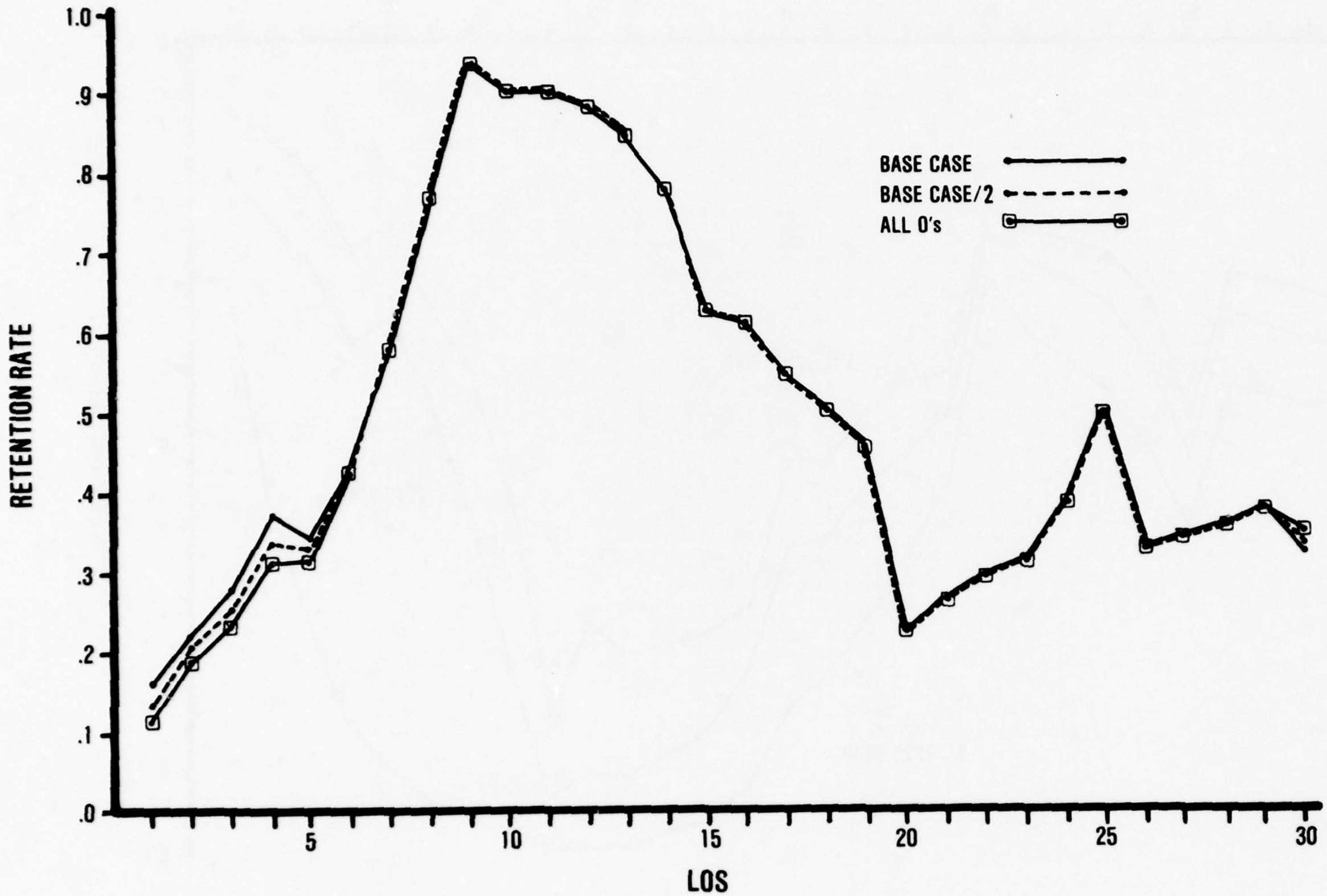

Figure 10. Changes in involuntary separation probabilities: Predicted retention rates for DoD retirement systems.

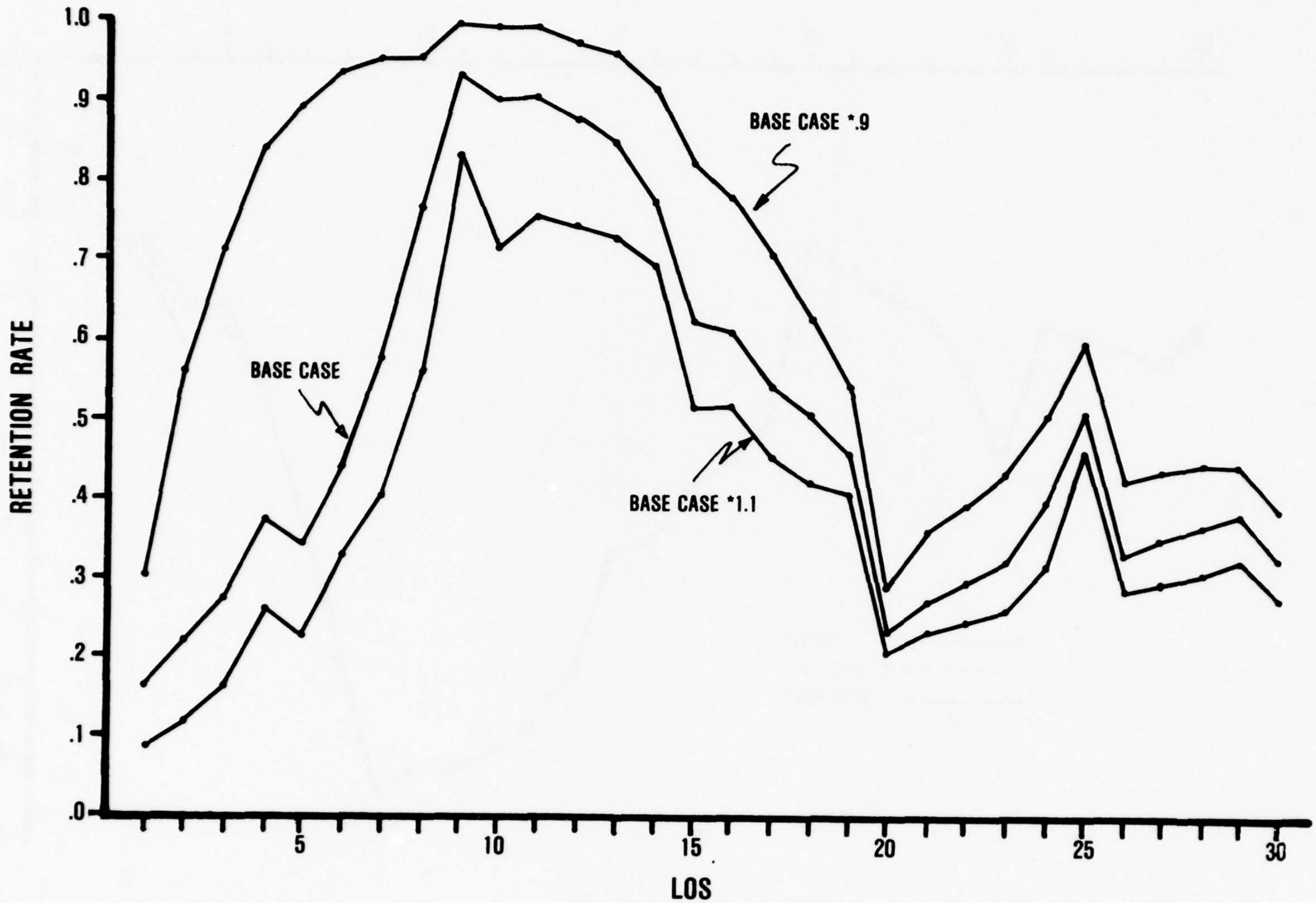

Figure 11. Proportional changes in civilian earnings: Predicted retention rates for DoD retirement system.

DISCUSSION AND CONCLUSIONS

Given a set of assumptions regarding the Navy enlisted personnel force structure, it is possible to analyze the force behavior effects of alternative retirement policies. Once explicit, these assumptions, combined with the dynamic programming approach of modelling the enlisted retention decision, become the basis for those techniques embraced in the model called RAM II. The model predicts PEBD retention and continuation rates for LOS cells 1-30 based on a set of three logit functions. Since RAM II is a highly flexible, interactive model, many alternative retirement systems can be analyzed in a short period of time. With the set of predicted ALNAV continuation rates for a given retirement system produced from RAM II, the transitional and steady state active duty and retirement costs for that system can then be produced by RAM I.

The primary objective underlying the analysis for the enlisted force is the development of a model similar to equations (2) through (4) for a variety of different enlisted occupational specialities. No analysis of alternative retirement systems can be considered complete until its effects on the individual Navy ratings (or groups of ratings) are known. An ALNAV analysis may determine that a given retirement system is acceptable for the Navy as a whole, but it may not pinpoint potential problems in particular ratings. For example, members of some ratings with high civilian employment opportunities might opt for civilian life under certain retirement scenarios. With an occupational-level model, it is possible to detect such problems.

The major payoff of such a development will depend, of course, on the success achieved in predicting occupational continuation rates as a function of economic incentives. At this time, efforts to determine behavior logit functions for 15 enlisted occupation groups are almost complete. The enlisted groups are classified on the basis of occupational and force behavior similarities. The results and extensions to incentive policies for these groups will be documented in a subsequent report.

Aside from current efforts in predicting occupational continuation rates, several other developments are being considered. One is the extension of the methods described in this report in developing a model that will predict the amount of additional incentives required to achieve a certain retention or continuation rate. Another is the design of a companion costing and/or force behavior model for the analysis of officer retirement.

From the findings of this effort, it is concluded that:

1. The dynamic programming model appears to explain much of the ALNAV enlisted retention behavior experienced in FY76 and FY77 under the current retirement system. As a result of the statistical relationship, it is fair to conclude that a model can be developed that will forecast retention rates under a variety of alternative retirement systems. The data requirements for such a model are large and require much organization and processing. Both the output from the dynamic programming model (the costs of leaving) and the LOS should be considered as possible predictor variables of retention rates.

2. Models similar to the ALNAV model can be developed for specific enlisted occupational groups to forecast reenlistment rates and LOS continuation rates for different skills or specialties. In this manner, the Navy will be able to predict the effects of a retirement system on its occupational communities. The data requirements are substantially greater than the ALNAV requirements, in terms of both processing and data acquisition.

3. While previous models were designed to cost alternative retirement systems, the model described in this report can be used to evaluate alternative economic incentives at any point in service in terms of resulting continuance behavior.

4. Based on preliminary analyses of two retirement proposals (PCMC and DoD) using RAM II, a substantial difference in enlisted retention is forecast relative to the current system. Particularly noticeable is the discrepancy in voluntary retention at those points of service lying between LOS 8 and LOS 20. This suggests that special attention be given to personnel in "mid-career" under the proposed retirement systems.

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APPENDIX A

DATA DEFINITIONS

DATA DEFINITIONS

To satisfy the various data requirements for the dynamic programming model and the subsequent behavior forecasting model, total Navy enlisted personnel movements for FY76 and FY77 were divided into several categories of changes (e.g., promotions and retirements). The data source was the Enlisted Personnel Planning Data Base (sometimes referred to as FAIM). The following variable identification numbers (VID) were used in defining the data:

Variable ID	Title
127	All Navy ineligibles
129	All Navy attrition
150	All Navy retirement
209	All Navy nonreenlistment
227	All Navy total eligible exp/sep--extended
410	All Navy continued service/broken service
433	USNR nonprior service
475	All Navy miscellaneous gains
500	All Navy total first enlistment
640	All Navy combined retention
817	All Navy promotions
830	All Navy demotions in
999	All Navy begin inventory

Each variable ID is in the form of a pay grade by length of service (LOS) (9 x 31) data array in which the LOS and pay grade are computed to the beginning of a fiscal year. For example, for a person who is an E-3 in LOS cell 4 at the beginning of the fiscal year and is promoted to an E-4 during that fiscal year, a count will be registered in the E-3/LOS 4 cell of VID 817. Since all the VIDs are begin-year, a fair amount of consistency is obtained in the following data definitions. The indicated division is on a cell-by-cell basis. VID 999 is, of course, begin-year by definition.

1. The conditional probability of a promotion, given that one is not involuntarily separated, for a given pay grade/LOS cell, is

$$\Pr(\text{Promotion} \mid \text{No involuntary separation}) = 817/(999+410+433+475+500+830-150-209-127-129).$$

In other words, it is the number of promotions divided by the net fiscal year's inventory less involuntary separations (127+129). Adding in the gains (410+433+475+500+830) and subtracting the losses (150+209) to the begin inventory 999 yields the net inventory for the fiscal year. That is, for each pay grade/LOS cell, those who were eligible for promotion (the denominator) include those who were present at the beginning of the year plus any gains to that pay grade/LOS cell during the year less any losses from that pay grade/LOS cell during the cell. The probabilities are made conditional by subtracting the involuntary separations from the net inventory. This is a requirement of the Gotz dynamic programming model.

Table A-1 gives the average of the FY76 and FY77 conditional promotion probabilities. For sparsely populated cells, the average of cells 4 and 5 were used for cells 4-31 for pay grade E-1; the average of cells 5 and 6, for cells 5-31 for E-2; the average of cells 11 and 12, for cells 11-31 for E-3; the average of cells 14 and 15, for cells 14-31 for E-4; and the average of cells 29 and 30, for cells 29-31 for E-5. The continuation of these probabilities down to LOS 31 for the sparsely populated cells is another requirement of the dynamic programming model since no official "up-or-out" policy exists for enlisted personnel.

Table A-1

Conditional Promotion Probabilities
(Average of FY76, FY77)

LOS	E-1	E-2	E-3	E-4	E-5	E-6	E-7	E-8	E-9
1	.582	.811	.382	.080	.000				
2	.539	.742	.680	.262	.000				
3	.486	.604	.735	.466	.003	.000			
4	.476	.532	.661	.665	.161	.000			
5		.422	.450	.530	.135	.003	.000	.000	.000
6			.249	.448	.185	.002	.000	.000	
7			.588	.536	.231	.005	.000	.000	
8			.642	.594	.276	.017	.000	.000	
9			.509	.579	.283	.075	.000	.000	
10			.509	.579	.315	.100	.003	.000	
11			.494	.652	.319	.109	.010	.000	
12				.651	.327	.123	.059	.000	
13				.649	.359	.152	.098	.000	
14				.612	.363	.161	.086	.067	
15				.608	.358	.172	.094	.081	
16					.356	.170	.100	.071	
17					.311	.176	.110	.071	
18					.322	.170	.096	.073	
19					.352	.180	.098	.134	
20					.421	.191	.107	.152	
21					.357	.197	.100	.134	
22					.368	.181	.092	.155	
23					.322	.178	.093	.134	
24					.501	.156	.065	.139	
25					.361	.188	.070	.120	
26					.350	.133	.054	.107	
27					.100	.160	.061	.119	
28					.143	.132	.043	.067	
29					.459	.102	.045	.070	
30					.459	.061	.086	.122	
31					.459	.070	.049	.063	

2. The probability of being involuntarily separated, for a given pay grade/LOS cell, is

Pr(Involuntary Separation)=(127+129)/(999+410+433+475+500+830-150-209).

The rationale follows the same lines as for the promotion probabilities. Table A-2 gives the average of FY76 and FY77 involuntary separation probabilities.

Table A-2

Involuntary Separation Probabilities
(Average of FY76, FY77)

LOS	E-1	E-2	E-3	E-4	E-5	E-6	E-7	E-8	E-9
1	.143	.189	.094	.165	.000				
2	.461	.171	.159	.085	.000				
3	.514	.396	.205	.090	.112	.000			
4	.516	.468	.339	.091	.331	.000			
5		.429	.234	.065	.044	.142	.000		
6			.119	.073	.057	.142	.000		
7			.162	.083	.041	.057	.000		
8			.207	.070	.047	.054	.000		
9			.153	.058	.036	.049	.000		
10			.160	.059	.036	.037	.158	.000	.000
11			.173	.061	.030	.029	.072	.000	.000
12				.075	.030	.021	.067	.000	.000
13				.072	.034	.021	.043	.000	.000
14				.122	.031	.016	.052	.134	.000
15				.084	.023	.014	.038	.094	.000
16					.019	.013	.030	.072	.000
17					.017	.009	.023	.051	.054
18					.018	.010	.015	.040	.048
19					.020	.013	.013	.030	.047
20					.080	.037	.038	.037	.040
21					.049	.042	.035	.030	.041
22					.055	.043	.030	.026	.030
23					.070	.039	.027	.024	.020
24					.114	.063	.038	.016	.021
25					.138	.056	.022	.014	.021
26					.000	.075	.036	.015	.026
27						.082	.048	.045	.018
28						.059	.041	.019	.017
29						.039	.028	.041	.019
30						.000	.087	.108	.041
31						.051	.072	.096	.053

3. The voluntary retention rates, matched with the costs of leaving from the dynamic programming model to determine the appropriate logit functions, are defined as:

$$\text{Voluntary Retention Rates} = 640/(150+227).$$

Thus, the rates are the number of people who continue divided by the number of people eligible to make a decision to continue. The average of FY76 and FY77 voluntary retention rates and the number of deciders are given in Table A-3. Recall, though, that the actual rates for each year, with the corresponding costs of leaving, were used in the determination of the logit functions, not the average values.

4. The weights assigned to each pay grade to determine one voluntary retention rate for each LOS cell are computed as:

$$\text{Pay Grade Weights} = (227+150)_{ij}/(227+150)_j \qquad \begin{array}{l} i = 1,\ldots,9 \text{ pay grades} \\ j = 1,\ldots,31 \text{ LOS cells} \end{array}$$

or, the cell-by-cell number of deciders divided by the total number of deciders for each LOS cell (the marginal total summed over all pay grades). Obviously, the weights must add to 1 when summed over the nine pay grades for each LOS cell. Table A-4 lists these weights, which are the average of the figures for FY76 and FY77.

5. The proportions of deciders, the number of people in each LOS cell who are eligible to make a decision to stay or leave, is a 1 x 31 vector and is calculated as:

$$\text{Proportion of Deciders} = (227+150)_j/999_j \qquad j = 1,\ldots,31 \text{ LOS cells.}$$

These numbers are used in combining the forecasted retention rates with the nondecider's continuation rates to give an overall LOS continuation rate. These weights, listed in Table A-5, are given to the retention rates with one minus these weights being assigned to the nondecider's continuation rates (see equation (5) in the main text). The figures in Table A-5 are the average of FY76 and FY77 numbers.

Table A-3

Voluntary Retention Rates and Number of Deciders
(Average of FY76, FY77)

LOS	E-1	E-2	E-3	E-4	E-5	E-6	E-7	E-8	E-9
1	.206(32)	.033(65)	.378(21)	.449(17)	.000(4)	--	--	--	--
2	.017(21)	.003(143)	.063(938)	.293(1852)	.993(193)	.250(2)	.000(1)	--	--
3	.063(44)	.046(230)	.179(2024)	.294(7365)	.725(897)	.999(2)	.999(1)	--	--
4	.140(24)	.162(110)	.250(848)	.284(12504)	.435(11380)	.505(32)	--	--	--
5	.167(12)	.152(14)	.357(280)	.317(2786)	.459(3498)	.558(30)	--	--	--
6	.200(3)	.167(2)	.503(69)	.399(825)	.253(2550)	.218(721)	--	--	--
7	.167(2)	.000(1)	.509(65)	.563(540)	.418(1389)	.440(536)	.999(3)	--	--
8	.000(2)	.072(5)	.574(70)	.646(810)	.573(1760)	.610(1305)	.950(15)	--	--
9	.000(1)	--	.517(15)	.697(194)	.647(1039)	.672(1391)	.954(41)	--	--
10	--	--	--	.758(145)	.762(1016)	.765(1560)	.951(109)	--	--
11	--	--	.375(4)	.661(64)	.777(500)	.791(822)	.922(132)	.999(3)	--
12	--	.000(1)	.833(3)	.900(60)	.850(540)	.861(1027)	.934(210)	.999(7)	--
13	--	--	.333(3)	.830(22)	.794(273)	.899(914)	.939(292)	.999(16)	--
14	--	--	.999(2)	.661(15)	.870(248)	.925(932)	.970(328)	.976(30)	.999(1)
15	--	--	.999(1)	.644(16)	.894(258)	.954(886)	.974(423)	.965(61)	.999(8)
16	--	.000(1)	.500(1)	.947(14)	.944(213)	.968(842)	.988(489)	.999(77)	.999(14)
17	--	--	.833(2)	.771(7)	.862(101)	.972(560)	.995(462)	.990(106)	.999(19)
18	--	--	--	.650(6)	.959(64)	.969(875)	.997(364)	.997(99)	.999(27)
19	--	--	--	.584(3)	.915(31)	.966(270)	.965(319)	.972(103)	.940(31)
20	.000(4)	.000(5)	.000(12)	.125(24)	.080(310)	.098(2514)	.148(2460)	.195(650)	.223(211)
21	--	--	.000(2)	.111(6)	.210(84)	.174(913)	.261(1119)	.341(378)	.386(166)
22	--	--	--	.333(2)	.230(55)	.326(506)	.248(810)	.354(250)	.332(126)
23	--	--	--	.000(2)	.108(23)	.191(294)	.252(440)	.313(168)	.371(102)
24	--	--	--	.000(1)	.161(21)	.181(133)	.261(269)	.363(119)	.442(82)
25	--	--	--	--	.354(6)	.149(55)	.334(129)	.534(75)	.519(53)
26	--	--	--	.000(1)	.250(4)	.196(27)	.237(99)	.288(53)	.430(45)
27	--	--	--	.000(1)	.215(5)	.316(11)	.379(59)	.369(31)	.397(44)
28	--	--	--	--	.000(2)	.203(13)	.278(46)	.329(33)	.429(43)
29	--	--	--	.000(1)	.000(1)	.550(7)	.231(46)	.151(37)	.130(46)
30	--	--	--	.000(1)	.500(2)	.134(16)	.079(115)	.097(82)	.097(97)
31	--	--	--	--	.225(5)	.224(25)	.098(112)	.297(89)	.235(111)

Table A-4

Pay Grade Weights for Determining the Voluntary
Retention Rate for Each LOS Cell

LOS	E-1	E-2	E-3	E-4	E-5	E-6	E-7	E-8	E-9
1	.221	.487	.144	.120	.028	.000			
2	.007	.045	.298	.588	.061	.000			
3	.004	.022	.192	.697	.085	.000			
4	.001	.004	.053	.492	.448	.001	.000		
5	.001	.002	.042	.421	.529	.005	.000		
6	.001	.000	.016	.198	.612	.172	.000		
7	.001	.000	.025	.213	.548	.211	.001	.000	.000
8	.000	.001	.018	.204	.444	.329	.004	.000	.000
9		.000	.005	.072	.388	.519	.015	.000	.000
10			.003	.051	.358	.550	.038	.000	.000
11			.003	.042	.328	.540	.086	.001	.000
12			.001	.033	.292	.556	.114	.004	.000
13			.002	.014	.179	.601	.192	.012	.000
14			.001	.010	.160	.600	.211	.019	.000
15			.000	.009	.156	.538	.257	.037	.002
16			.001	.008	.129	.511	.297	.046	.008
17			.002	.006	.080	.446	.367	.084	.015
18			.000	.006	.067	.414	.376	.103	.028
19		.000	.000	.003	.041	.357	.422	.136	.040
20		.001	.002	.004	.050	.406	.397	.105	.034
21		.000	.000	.002	.031	.343	.420	.142	.062
22				.001	.031	.289	.463	.143	.072
23				.001	.022	.286	.428	.164	.099
24				.001	.033	.213	.431	.191	.131
25				.000	.017	.172	.407	.236	.168
26				.002	.015	.115	.426	.249	.193
27				.003	.030	.074	.394	.205	.293
28				.000	.011	.096	.336	.240	.317
29				.004	.007	.048	.335	.268	.338
30				.002	.003	.050	.369	.263	.313
31				.000	.013	.072	.328	.261	.326

Table A-5

Proportions of Deciders by LOS Cell

LOS	Proportion	LOS	Proportion
1	.0019	17	.1325
2	.0419	18	.1278
3	.1688	19	.3252
4	.5836	20	.4262
5	.2714	21	.4024
6	.2257	22	.4100
7	.1400	23	.3963
8	.2556	24	.3567
9	.2347	25	.2891
10	.2961	26	.3658
11	.1723	27	.3344
12	.2107	28	.2607
13	.1985	29	.2932
14	.1924	30	.5309
15	.1834	31	.4535
16	.1796		

APPENDIX B

ANALYTICAL RESULTS

Table B-1

Actual and Predicted Retention and Continuation Rates for Current System

	Retention Rate		Continuation Rate	
LOS	Actual	Predicted	Actual	Predicted
1	.1661	.1579	1.0338	1.0338
2	.2509	.2236	.8010	.7999
3	.3107	.2722	.6983	.6918
4	.3493	.3727	.5109	.5245
5	.3933	.3383	.8152	.8003
6	.2808	.4334	.9452	.9797
7	.4559	.4904	.9052	.9100
8	.6010	.6069	.8863	.8878
9	.6680	.7129	.9207	.9312
10	.7460	.7267	.9336	.9180
11	.7925	.7847	.9626	.9612
12	.8674	.8548	.9673	.9647
13	.8873	.9117	.9723	.9772
14	.9246	.9423	.9751	.9785
15	.9500	.9592	.9841	.9858
16	.9717	.9725	.9859	.9860
17	.9719	.9815	.9874	.9887
18	.9852	.9803	.9874[a]	.9868
19	.9664	.9881	.9874[a]	.9963
20	.1305	.2304	.4746[a]	.5138
21	.2474	.2292	.6914	.6841
22	.2561	.2821	.6873	.6979
23	.2523	.2327	.6977	.6899
24	.2835	.2791	.7423	.7407
25	.3791	.4195	.8202	.8319
26	.2818	.2291	.7292	.7100
27	.3796	.2213	.7929	.7393
28	.3240	.2139	.8374	.7946
29	.1876	.2077	.7211	.7270
30	.1544	.1477	.5641	.5666

[a]Changed from actual rates to reflect a full 20 YOS for retirement eligibility.

Table B-2

Predicted Retention and Continuation Rates for
Current, PCMC, and DoD Retirement Systems

	Retention Rates			Continuation Rates		
LOS	Current	PCMC	DoD	Current	PCMC	DoD
1	.1579	.1585	.1585	1.0338	1.0338	1.0338
2	.2236	.2241	.2241	.7999	.7999	.7999
3	.2722	.2729	.2729	.6918	.6919	.6919
4	.3727	.3740	.3740	.5245	.5253	.5253
5	.3383	.3432	.3432	.8003	.8016	.8016
6	.4334	.4401	.4426	.9797	.9812	.9817
7	.4904	.5228	.5762	.9100	.9145	.9220
8	.6069	.7440	.7667	.8878	.9229	.9287
9	.7129	.9252	.9360	.9312	.9800	.9827
10	.7267	.7396	.9001	.9180	.9338	.9739
11	.7847	.6857	.9031	.9612	.9199	.9743
12	.8548	.6516	.8782	.9647	.9084	.9650
13	.9117	.6037	.8471	.9772	.8960	.9568
14	.9423	.5673	.7727	.9785	.8821	.9335
15	.9592	.5137	.6274	.9858	.8723	.9007
16	.9725	.4773	.6119	.9860	.8611	.8947
17	.9815	.4377	.5460	.9887	.8518	.8788
18	.9803	.4079	.5052	.9868	.8427	.8671
19	.9881	.4019	.4569	.9963	.8486	.8623
20	.2304	.2570	.2307	.5138	.8100	.8034
21	.2292	.2818	.2723	.6841	.8132	.8109
22	.2821	.3136	.2926	.6979	.8186	.8133
23	.2327	.3347	.3225	.6899	.8263	.8232
24	.2791	.3815	.3925	.7407	.8429	.8457
25	.4195	.4760	.5136	.8319	.8687	.8781
26	.2291	.5427	.3313	.7100	.8761	.8233
27	.2213	.6789	.3491	.7393	.9193	.8369
28	.2139	.8107	.3639	.7946	.9522	.8405
29	.2077	.9187	.3815	.7270	.9365	.8022
30	.1447	.3627	.3269	.5666	.6823	.6633

Table B-3

Changes in Involuntary Separation Probabilities: Predicted Retention and Continuation Rates for DoD Retirement System

	Probabilities					
	Retention Rate			Continuation Rate		
LOS	Base Case	Base Case/2.	All 0's	Base Case	Base Case/2.	All 0's
1	.159	.137	.119	1.034	1.034	1.034
2	.224	.208	.192	.800	.799	.799
3	.273	.252	.233	.692	.688	.685
4	.374	.341	.310	.525	.506	.488
5	.343	.330	.318	.802	.798	.795
6	.443	.438	.436	.982	.981	.980
7	.576	.582	.589	.922	.923	.924
8	.767	.771	.777	.929	.930	.931
9	.936	.939	.942	.983	.983	.984
10	.900	.903	.906	.974	.975	.975
11	.903	.905	.907	.974	.975	.975
12	.878	.879	.880	.965	.965	.966
13	.847	.848	.849	.957	.957	.957
14	.773	.773	.773	.934	.934	.934
15	.627	.626	.624	.901	.900	.900
16	.612	.611	.610	.895	.895	.894
17	.546	.545	.544	.879	.879	.878
18	.505	.504	.503	.867	.867	.867
19	.457	.456	.456	.862	.862	.862
20	.231	.228	.225	.803	.803	.802
21	.272	.270	.268	.811	.810	.810
22	.293	.290	.288	.813	.813	.812
23	.323	.320	.317	.823	.823	.822
24	.393	.389	.386	.846	.845	.844
25	.514	.512	.511	.878	.878	.877
26	.331	.327	.324	.823	.822	.821
27	.349	.344	.339	.837	.836	.835
28	.364	.361	.357	.841	.840	.839
29	.382	.379	.376	.802	.802	.801
30	.327	.337	.348	.663	.669	.675

Table B-4

Proportional Changes in Civilian Earnings: Predicted Retention and Continuation Rates for DoD Retirement System

	Retention Rates			Continuation Rates		
LOS	.9	1.0[a]	1.1	.9	1.0[a]	1.1
1	.302	.159	.082	1.034	1.034	1.034
2	.562	.224	.120	.814	.800	.796
3	.717	.273	.160	.767	.692	.673
4	.842	.374	.259	.798	.525	.458
5	.892	.343	.227	.951	.802	.770
6	.941	.443	.328	1.094	.981	.956
7	.953	.576	.400	.975	.922	.897
8	.954	.767	.557	.977	.929	.875
9	.992	.936	.837	.997	.983	.958
10	.986	.900	.720	.996	.974	.929
11	.984	.903	.752	.995	.974	.937
12	.974	.878	.741	.989	.965	.931
13	.959	.847	.732	.985	.957	.928
14	.919	.773	.689	.970	.934	.913
15	.825	.627	.512	.950	.901	.872
16	.780	.612	.517	.937	.895	.871
17	.706	.546	.449	.919	.879	.855
18	.629	.505	.422	.898	.867	.846
19	.544	.457	.406	.884	.862	.850
20	.287	.231	.202	.817	.803	.796
21	.354	.272	.231	.831	.811	.801
22	.388	.293	.244	.837	.813	.801
23	.431	.323	.259	.850	.823	.807
24	.502	.393	.319	.873	.846	.827
25	.600	.514	.460	.900	.878	.865
26	.422	.331	.282	.846	.823	.811
27	.438	.349	.293	.859	.837	.823
28	.443	.364	.306	.860	.841	.826
29	.440	.382	.326	.817	.802	.788
30	.386	.327	.273	.695	.663	.635

[a]Base Case.

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